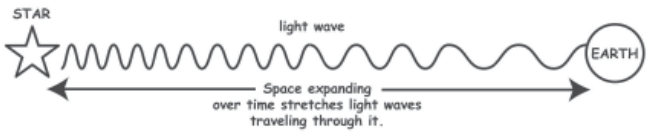
Clues from Ancient Light

Some people are good at telling other people's ages. They can look at you and know you are 9 years old or 22 or 49 or 99. How? They read the clues: your size, shape, proportion, gray hair (or no hair), wrinkles, how you talk, and how you act.

Astronomers know how to tell the ages of the stars—or least the ages of the stars' light. What clues do they use? Light changes as it travels through space and time. It's as if, like aging humans, the light gets "tired." Light that has been traveling a long, long time (say, billions of years) starts looking pretty tired! Astronomers say that the light is ***red-shifted***, because red light has the least energy of all the colors of the light we can see with our eyes.

No matter how "old and tired" light is, it always travels at the same speed in space: 300,000 kilometers (or 186,000 miles) per second (in round numbers). That means it takes some amount of time—a little or a lot—for light to get anywhere. The distance light can travel in one Earth year is called a ***light year***. A light year is very long distance: around 9 trillion kilometers (6 trillion miles).



Light travels in waves, just as energy traveling through the ocean pushes the water into waves. But as light waves travel through space, they gradually get stretched out. That is because, along with the universe, space itself is expanding and stretching the distances between things.

GALEX Looks Back in Time

GALEX (short for Galaxy Evolution Explorer) is a space telescope that was launched into orbit around Earth in 2003. From space, GALEX gets a great view of the ultraviolet light from stars, without Earth's atmosphere getting in the way.

GALEX is now looking at most of the galaxies in the Universe. A galaxy is a grouping of stars. All but a few stars in the universe live in galaxies. Our Sun is just one of at least 200 billion stars in our own Milky Way Galaxy.

GALEX sees starlight that has been traveling for just a few years from stars that are "only" a few trillion kilometers away. But it also sees really "tired" starlight that has been traveling over 10 billion years! That is more than two-thirds of the age of the whole Universe! So GALEX is seeing galaxies as they were 10 billion years ago, as well as how the nearby galaxies looked just a few hundred thousand years ago. Just as you look younger in a picture of you from several years ago, GALEX sees pictures of galaxies when they were much younger than now. So astronomers can look at the young galaxy pictures from far away (and long ago), compare them with pictures of older galaxies nearby (very recent) and see how galaxies and their stars are born, age, and die over time. They can learn how galaxies *evolve*.

How Old Do I Look?

Can you tell how old something is just by looking at it? The squares on the next page contain pictures of old things, new things, and every age in between things. Cut out the squares. For each row (A – F) of six pictures from a single category, like nature or animals, arrange the objects by age, oldest on the left, youngest on the right. Some things may be a little hard to compare, but make a good guess anyway. At least be able to explain why your arrangement by age could be right! Compare your best guesses to ours on Page 3.

Learn More

Books:

Universe by Robin Kerrod, DK EYEWITNESS BOOKS, 1st ed. (March 2003), ISBN: 0789492385 (ages 9-12).

Galaxies by Seymour Simon, HarperTrophy, Reprint ed., 1991, ISBN: 0688109926 (ages 9-12)

Our Galaxy and the Universe by Ken Gruan et al., Ken Press, 2002, ISBN: 1928771084 (ages 9-12).

Websites:

GALEX Website, **http://www.galex.caltech.edu**. See "Image Gallery."

The Space Place, **http://spaceplace.nasa.gov**. Under "Projects," see "Galactic Mobile" and "Galaxy Montage" activities.

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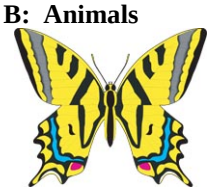
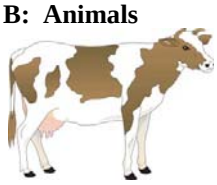
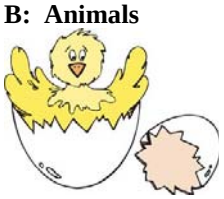
CUT OUT SQUARES. IN EACH ROW, ARRANGE OLDEST TO NEWEST (LEFT TO RIGHT).

A: Nature  Earth	**A: Nature**  Tree	**A: Nature**  Galaxy	**A: Nature**  Bee hive	**A: Nature**  Mountain	**A: Nature**  Flower
B: Animals  Baby	**B: Animals**  Butterfly	**B: Animals**  Milk cow	**B: Animals**  Old man	**B: Animals**  Giant tortoise	**B: Animals**  Baby bird
C: Transportation  Pegasus rocket (launched GALEX space telescope)	**C: Transportation**  Covered wagon	**C: Transportation**  First metal bike	**C: Transportation**  Viking ship	**C: Transportation**  Wright brothers' airplane	**C: Transportation**  Volkswagen Beetle
D: Communication  Telephone (rotary dial)	**D: Communication**  Cell phone	**D: Communication**  Telephone (separate ear & mouth pieces)	**D: Communication**  Telephone (combined ear & mouth pieces)	**D: Communication**  GALEX ground station antenna	**D: Communication**  Smoke signals
E: "Short timers"  Cloud	**E: "Short timers"**  Soap bubble	**E: "Short timers"**  Birthday candle flame	**E: "Short timers"**  Flower	**E: "Short timers"**  Lightning	**E: "Short timers"**  Leaf
F: "Imagers"  GALEX space telescope	**F: "Imagers"**  Box camera	**F: "Imagers"**  Isaac Newton's Telescope	**F: "Imagers"**  35-millimeter film camera	**F: "Imagers"**  Digital camera	**F: "Imagers"**  Cave painting

ANSWERS!

A  This galaxy, M81, is over 10 billion years old. Picture taken by the GALEX telescope.	**A**  Earth is about 4-1/2 billion years old.	**A**  Mountains can be almost as old as Earth itself. Some are just a few million years old.	**A**  Trees can be hundreds of years old. This one looks at least a few years old.	**A**  This beehive is likely to be at least a few days old. It could be older than the tree though!	**A**  This daffodil looks very fresh, probably just a day or two old.
B  Giant tortoises can live from 150-200 years! This one may not be that old, but it might be over 100.	**B**  This man looks about 80 or 90 years old.	**B**  Cows must bear a calf before they can give milk. They are usually at least two years old.	**B**  This baby is crawling, so he is probably between six months and one year old.	**B**  Butterflies we see are in the last part of their life cycle. This phase usually lasts only about one week.	**B**  This little chick has just hatched and is still in his shell. It may be only a few minutes old.
C  This ship might have been used by the Viking warriors more than 1000 years ago.	**C**  Covered wagons were used by the settlers of the western U.S. during the 1800s.	**C**  The first all-metal bicycle appeared in 1870. Covered wagons were still in use though!	**C**  Wright brothers' airplane flew successfully in 1903.	**C**  The last Volkswagen Beetle "love bug" was made in 1978.	**C**  The Pegasus rocket was first launched from a big airplane in 1990. It launched GALEX in 2003.
D  Native Americans "talked" by smoke signals long before Europeans arrived in the 1600s.	**D**  This kind of telephone appeared during the early 1900s.	**D**  This later model has a rotary dial. The ear and mouth pieces can be held in one hand.	**D**  This kind of rotary phone appeared in the late 1950s.	**D**  This cell phone is one of the newest models. May be newer than GALEX ground antenna.	**D**  GALEX ground stations in Hawaii and Australia began operating in 2002.
E  This leaf (if it is still on the tree) could be several days or weeks old.	**E**  This dandelion doesn't last long before it turns to a puff of fuzzy seeds that blow away.	**E**  How old is a cloud? Clouds are always changing. But maybe it will look the same to you for a few minutes.	**E**  This candle is very small so the flame will burn for only a couple of minutes.	**E**  A bubble floating in the air is fragile and usually pops in a few seconds.	**E**  Up to 18 lightning bolts can strike in one second, so this one must be very young indeed!
F  Cave paintings date from over 15,000 years ago.	**F**  Isaac Newton designed the first reflecting telescope in 1672.	**F**  This box camera was probably made in the 1950s.	**F**  This "look through the lens" camera is most likely newer than the box camera.	**F**  Digital cameras like this are the latest advance in photography. First sold in the 1990s.	**F**  GALEX space telescope, launched in 2003, has very advanced imaging instruments.